Upper Ordovician brachiopods and trilobites from the Clashford House Formation, near Herbertstown, Co. Meath, Ireland

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Synopsis

Brachiopods and trilobites are described for the first time from the Clashford House Formation, Co. Meath. The fauna comprises the brachiopods *Hibernodonta praeco* gen. et sp. nov. (a new genus of stropheodontid), *Plaesiomys* cf. *multiplicata, Oanduporella* cf. *reticulata, Sericoidea* cf. *abdita, Kiaeromena* sp. together with an indeterminate craniid and orthid, and the trilobites *Deacybele* aff. *arenosa, Harpidella*? sp., *Gravicalymene* sp., *Miraspis* sp. and an indeterminate lichid. The assemblage indicates a late Ordovician (Caradoc) age for the formation and probably inhabited the shelves and slopes of a volcanic archipelago seaward of the Anglo-Welsh and Irish Sea areas.

Introduction

The fauna described in this paper was collected from a small outcrop on the west bank of the River Delvin in the townland of Naul, Co. Meath. The locality lies approximately 880 m north-east of Naul, which is situated some 7·5 km SSW of Balbriggan, Co. Dublin (Romano 1980*b*; Fig. 1 herein). The area had received scant attention since the explanatory Memoir of 1871 (Hull & Cruise) until Romano (1970, 1980*b*) revised the succession and recognized the presence of probable Ordovician rocks.

The fossiliferous outcrop is assigned to the Clashford House Formation (Romano 1980*b*), a unit which underlies a dominantly volcanic sequence of tuffs and lavas showing close petrographical similarity to the volcanic rocks of Balbriggan farther east (France 1967). Shelly faunas also occur at Balbriggan and, from France's interpretation of the structure of the area, are from mudstones underlying the volcanic rocks.

The Clashford House Formation consists of cleaved grey mudstones with rare silty bands. The mudstones are typically rather blocky and homogeneous; lamination and banding only occur where the beds become more silty. On the basis of a sparse fauna, Mitchell (*in* Romano 1980*b*: 206) suggested that the brachiopods indicated a late Ordovician, possibly early Ashgill age. The acritarchs recovered from the sample proved inconclusive. Further collections by D. A. T. Harper & W. I. Mitchell have now yielded a much richer fauna which provides the basis for the present paper.

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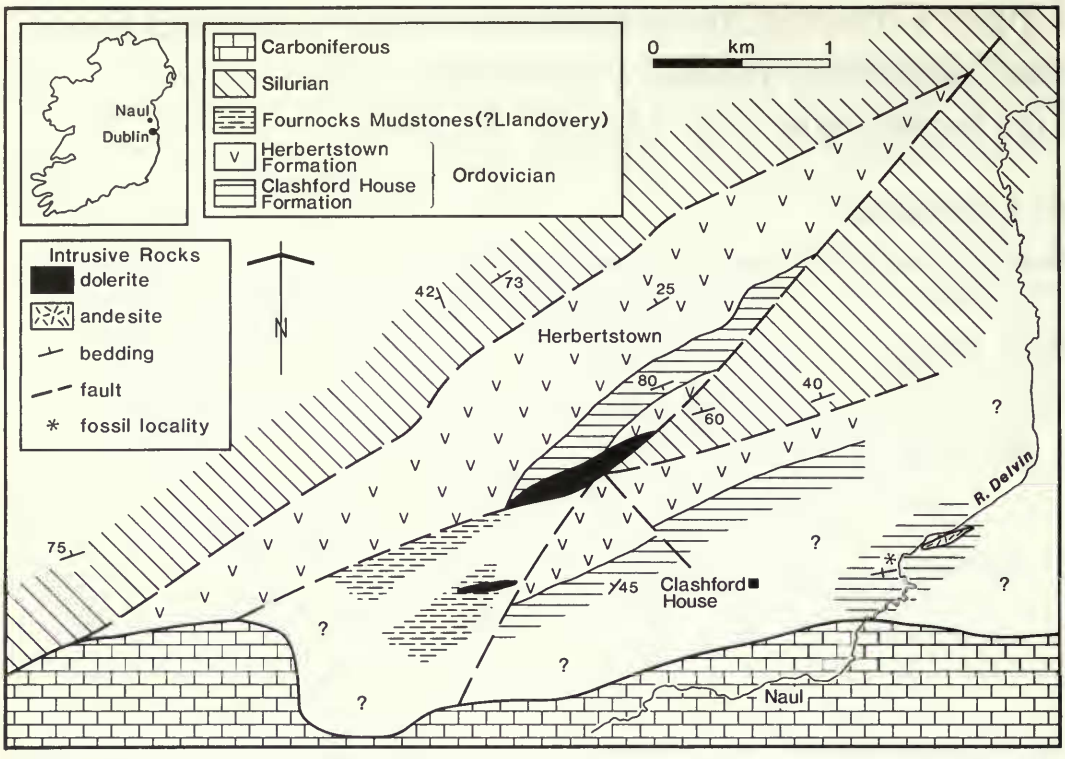


Fig. 1 Simplified geological map of the Herbertstown area (after Romano 1980*b*: fig. 1) showing the fossil locality mentioned in the text. The Silurian rocks, apart from the Fournocks Mudstones, belong to the Skerries Formation of *lundgreni* Zone age (late Wenlock) or younger (Rickards *et al.* 1973).

The general area from which the material was collected was referred to as the Herbertstown area by Romano (1980*b*), since it is in this townland that the volcanic rocks in particular are best exposed. For convenience, the material described here is known as the Herbertstown fauna.

All type and figured material has been given to the British Museum (Natural History) (Brachiopods BC.9171–9197; Trilobites It.17040–17051); a selection of comparative material is in the Ulster Museum, Belfast.

The systematic palaeontology of the Brachiopoda is by D. A. T. Harper & W. I. Mitchell, and of the Trilobita by A. W. Owen & M. Romano.

Correlation and environmental setting

In a preliminary assessment of the age of the Clashford House Formation, Romano (1980*b*: 208) considered the unit to correlate with the Caradoc/Ashgill on the basis of very limited palaeontological evidence. The new collections provide a more precise age for these strata.

Although none of the Herbertstown brachiopods is unequivocally assigned to established species, three, *Plaesiomys* cf. *multiplicata, Oanduporella* cf. *reticulata* and *Sericoidea* cf. *abdita*, are sufficiently similar to the named species to permit a tentative correlation of the Clashford House Formation with sequences elsewhere. The genus *Oanduporella* Hints is typical of a restricted facies in the Oandu Stage of the east Baltic; the type species, with

which the Irish specimens are compared, has been recorded from the 'Oandu Member' of the Oandu Stage of northern Estonia and the Oandu Stage of south-east Estonia and Lithuania (Hints 1975: 105). Both horizons are upper Caradoc (probably high Marshbrookian to low Onnian) equivalents. But since the precise range of only the type species is known with certainty, in Estonia and Lithuania, the use of *Oanduporella* for accurate correlation is at present limited. *P. multiplicata* is from high Soudleyan strata at Glyn Ceiriog. Since *Sericoidea abdita* Williams was initially described from the Derfel Limestone (Costonian) of north Wales, forms approximating to it have been described from the Balclatchie Mudstones (low Caradoc; Ingham 1978: 167) of the Girvan district, the Hagley Shales (Soudleyan) of the Shelve inlier (Williams 1974: 139) and the Tandinas Shales (Costonian) on Anglesey (Bates 1968: 173). The other elements of the brachiopod fauna, with the exception of *Hibernodonta praeco*, indicate, on balance, a middle Caradoc (Soudleyan–Longvillian) age for the Clashford House Formation.

Of the trilobites, only the *Deacybele* provides any indication of the precise age of the Herbertstown fauna. Other forms ascribed to the genus are restricted to the Caradoc and lowest Ashgill (on the basis of current correlations), and if the suggested similarity to *D. arenosa* (M'Coy) is correct a Caradoc age is probable.

No comparable brachiopod faunas have yet been described from the Caradoc of eastern Ireland. However, farther east at Balbriggan, Mason (*in* France 1967: 291) identified a Longvillian fauna from, principally, mudstones associated with a sequence of basic-intermediate volcanic and volcaniclastic rocks. Romano (1980*b*: 212) considered the Balbriggan fauna to be from mudstones beneath the volcanic rocks and suggested a tentative correlation with the Clashford House Formation; the new palaeontological data presented herein confirms this. These data provide important constraints regarding the timing of volcanism in eastern Ireland.

Elsewhere in Ireland formations at Bellewstown, Grangegeeth, Rathdrum, Enniscorthy, Courtown and Tramore have been correlated with the middle Caradoc (Brenchley *et al.* 1977 and references therein; Carlisle 1979; Romano 1980*a*). To date, however, no brachiopod faunas similar to that from the Clashford House Formation have been recorded from these areas.

Table 1 Sample count of the brachiopod fauna of the Clashford House Formation. Abbreviations: PV – pedicle valves, BV – brachial valves, ? – indeterminate valves, BKN – broken valves. Only five conjoined pairs, all of *Oanduporella* cf. *reticulata*, were recovered during the present study; these are included in the sample count.

	PV	BV	?	BKN	Total	%
Craniid gen. et sp. indet.	1	–	–	–	1	1
Orthid gen. et sp. indet.	1	–	3	3	4	4
Plaesiomys cf. *multiplicata*	15	8	5	22	28	31
Oanduporella cf. *reticulata*	17	18	4	25	39	43
Sericoidea cf. *abdita*	6	2	–	4	8	9
Kiaeromena sp.	2	–	–	2	2	2
Hibernodonta praeco gen. et sp. nov.	2	3	4	5	9	10

Data on the abundance and breakage of the Herbertstown brachiopods are summarized in Table 1. Most of the brachiopod shells are slightly broken and disarticulated, as are all the trilobites. However, a wide individual size range is represented in the larger samples. The fauna comprises both pedunculate and non-pedunculate forms, whilst elements considered to be typical of shallow (*Plaesiomys*) and deep (*Sericoidea*) palaeocommunities in the Caradoc (Pickerill & Brenchley 1979; Hurst 1979; Lockley 1983) occur together. Romano (1980*b*:

214) suggested that the early Caradoc benthos of eastern Ireland may have occupied the shallow water shelves around volcanic centres. A similar environment for the Herbertstown fauna is envisaged, although it seems likely that it has been rapidly transported down-slope prior to final burial in deeper water on the unstable slopes of the volcanic islands.

The brachiopods are more similar to those of the Baltic and Anglo-Welsh provinces; they have little in common with coeval assemblages from the North American and Mediterranean provinces. A situation seaward of the Baltic and Anglo-Welsh plates at high to intermediate latitudes (see Cocks & Fortey 1982) is therefore suggested.

Systematic palaeontology: Brachiopoda

Although much of the material is well preserved it is largely broken and has suffered some tectonic deformation. Consequently statistics and precise measurements of variates are not available. However, fractions in words, based on the sample means of estimated values of given variates, are provided in the taxonomic descriptions as a rough guide to the relative dimensions of features of the shell. The terminology is that of Williams *et al.* (1965). Measurements may be made from the figures for which the given magnifications are accurate to within 5%. All figured specimens have been lightly coated with ammonium chloride sublimate and photographed in the conventional manner.

Specimens of *Plaesiomys* cf. *multiplicata* (Fig. 11) and *Kiaeromena* sp. (Figs 43–46) have been extensively bored; the borings will be described elsewhere as a separate part of this study.

Suborder **CRANIIDINA** Waagen, 1885

Superfamily **CRANIACEA** Schuchert, 1896

Family **CRANIIDAE** Menke, 1828

Craniid gen. et sp. indet.
Figs 2–3

MATERIAL. One virtually complete but poorly preserved valve.

DESCRIPTION. Small, convex valve of elongate subcircular outline, about as long as wide and about one-fifth as deep as long. Anterior and lateral profiles weakly convex with broad, shallow sulcus pronounced anteriorly; umbo subdued. Hinge line curved, about four-fifths maximum width which occurs at about mid-valve length. Ornament of very fine costellae, with about 20 per mm medially at the 2·5-mm growth stage; concentric growth lines variably accentuated with 4 per mm developed at anterior margin, where a feeble limbus is present.

DISCUSSION. This small, poorly preserved valve is assigned with difficulty to the Craniidae largely on account of its shape and probable calcareous shell. Although there is little indication which valve the mould represents, the low convexity and submarginal umbo suggest the pedicle valve. Of the known genera of craniids it is most similar to *Orthisocrania*; it has a fine costellate ornament, a submarginal beak and a definite limbus. It is noteworthy that in his review of the distribution of *Orthisocrania* in the British Isles, Wright (1970: 101) considered it to be restricted to rocks of Longvillian age, although it may have arrived earlier, during for example the Soudleyan Stage (Wright 1970: 102). A more precise assignment of this specimen is clearly not warranted since the shell is small, probably immature and poorly preserved; moreover, information regarding the brachial valve and both valve interiors is lacking.

Suborder **ORTHIDINA** Schuchert & Cooper, 1932

Subfamily **ORTHACEA** Woodward, 1852

Family **ORTHIDAE** Woodward, 1852

Orthid gen. et sp. indet.
Figs 4–5

Material. One incomplete pedicle valve and a few fragments bearing a similar style of ornament.

Discussion. The most complete valve is that figured; it is about as wide as long and about one-fifth as deep. The anterior profile is convex medially with flatly concave flanks and the lateral profile slopes gently anteriorly from the small convex ventral umbo. About 17 strong costae are present with fairly angular profiles and except the median costa all others appear to develop costellae by internal and external branching with the order as follows: $5a^{-}$, $4a^{-}$, $3a^{\circ}$, $2a^{\circ}$, $1a^{-}$. The earliest costella appears at the 3-mm growth stage. The median rib (unnumbered) has a wavelength of 0·75 mm at the 5-mm growth stage. A concentric ornament of well-defined growth lines, six per mm at the 5-mm growth stage medially, is developed. Although the valve has been slightly deformed the shape and ornament suggest inclusion within the genus *Nicolella* (Reed, 1917). The high number of costae and the early appearance of costellae by external and internal branching indicate a similarity to *N. humilis* Williams (*in* Whittington & Williams 1955: 405) from the Derfel Limestone (Costonian), rather than to stratigraphically younger forms assigned to *N. actoniae* (J. de C. Sowerby), s.l. (see Williams 1963: 352 and Cocks 1978: 41).

Family **PLAESIOMYIDAE** Schuchert, 1913

Subfamily **PLAESIOMYINAE** Schuchert, 1913

Genus ***PLAESIOMYS*** Hall & Clarke, 1892

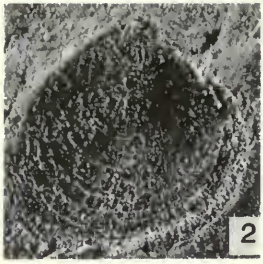
Type species. By original designation, *Orthis subquadrata* Hall, 1847, from the Richmond Group (upper Ordovician) of New York State, U.S.A.

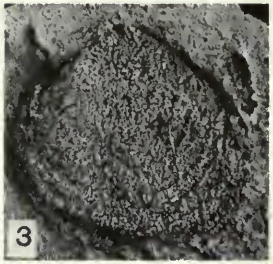
Plaesiomys cf. ***multiplicata*** Bancroft 1945
Figs 6–24

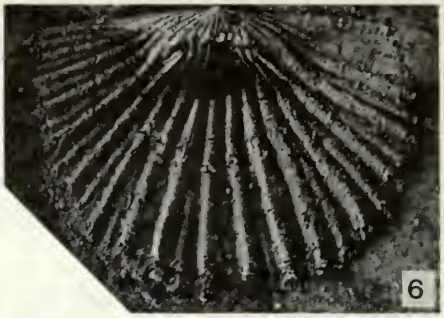
cf. 1945 *Dinorthis (Plaesiomys) multiplicata* Bancroft: 244; pl. 35, figs 4–6; pl. 36, figs 1–3.
cf. 1968 *Dinorthis multiplicata* Bancroft; Diggens & Romano: 47; pl. 5, fig. M.
cf. 1978 *Plaesiomys multifida* (Salter); Cocks: 50 (pars).
cf. 1978 *Dinorthis multiplicata* Bancroft; Brenchley: 160.
1980*b* *Lordorthis* sp.; Mitchell *in* Romano: 206.

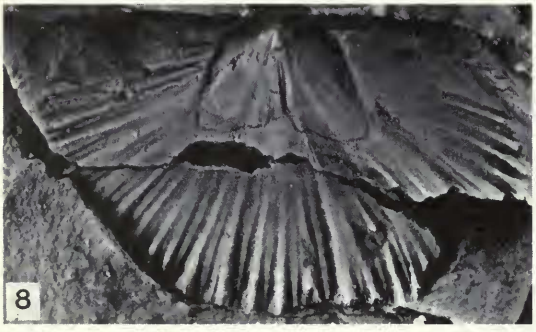
Material. Fifteen pedicle valves, eight brachial valves and five indeterminate valves.

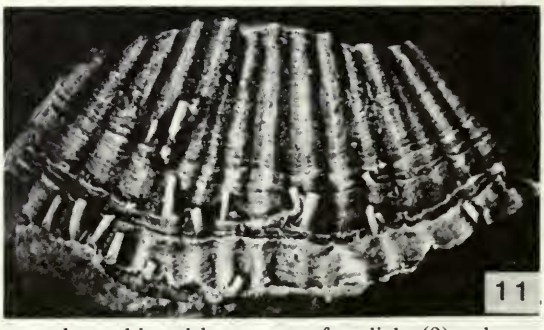
Description. Moderately large, dorsibiconvex to convexiplane valves of rounded subquadrate outline, with maximum width at between hinge line and one-third valve length; hinge width about four-fifths maximum width. Anterior commissure rectimarginate and cardinal extremities obtuse and rounded. Pedicle valve about three-quarters as long as wide and less than one-fifth as deep as long. Anterior profile with swollen axial surface posteriorly; elsewhere flanks and axial surface flat to weakly concave. Lateral profile feebly convex at and near fairly prominent umbo, elsewhere inclined gently anteriorly. Ventral interarea less than one-quarter valve length, flat and apsacline; delthyrium wide, open and rarely with indications of minute, subcircular, apical pedicle foramen. Brachial valve evenly convex in both profiles, about seven-eighths as long as wide; dorsal interarea short, flat and anacline with wide, open notothyrium. Radial ornament of subangular to evenly rounded costae,







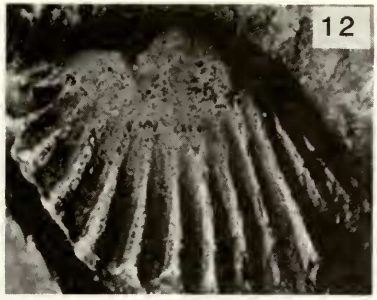


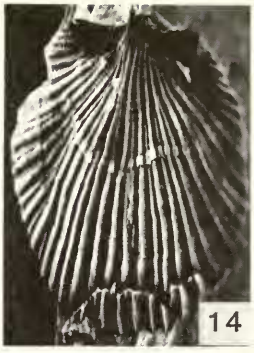


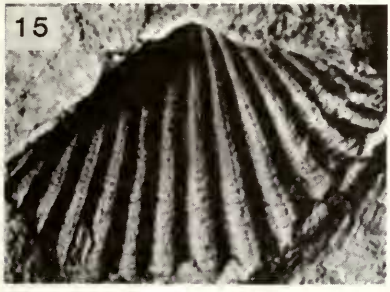
Figs 2–3 Craniid gen. et sp. indet. BC 9171, external mould and latex cast of pedicle (?) valve, both × 10. Clashford House Formation.

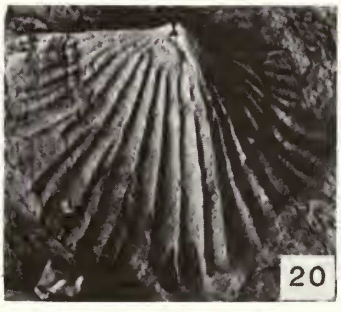
Figs 4–5 Orthid gen. et sp. indet. BC 9175, latex cast and external mould of pedicle valve, × 4. Clashford House Formation.

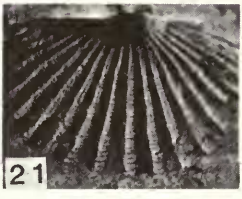
Figs 6–11 *Plaesiomys* cf. *multiplicata* Bancroft. Figs 6, 7, BC 9172, latex cast and external mould of pedicle valve, both × 5⅓. Figs 8, 10, 9, BC 9173, internal mould, latex cast and external mould, respectively, of pedicle valve, all × 2⅔. Fig. 11, BC 9174, part of anterior margin of pedicle valve with borings (see p. 290), × 4. Clashford House Formation. See also Figs 12–24.

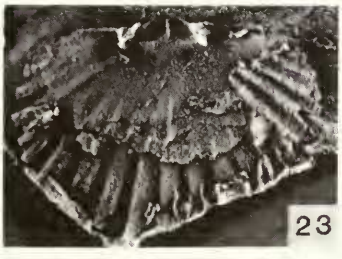












Figs 12–24 *Plaesiomys* cf. *multiplicata* Bancroft. Figs 12, 13, 14, BC 9176, internal mould, latex cast and external mould, respectively, of pedicle valve, all × 12. Figs 14, 18, 19, BC 9177, external mould of pedicle valve and external mould and latex cast of brachial valve, all × 3. Figs 16, 20, BC 9178, external mould and latex cast of pedicle valve, both × 5. Figs 17, 21, BC 9179, latex cast and external mould of pedicle valve, both × 6. Figs 22, 23, BC 9180, internal mould and latex cast of brachial valve, × 5½. Fig. 24, BC 9181, internal mould of pedicle valve, × 5. Clashford House Formation. See also Figs 6–11.

costellae and interspaces; 16–20 costae are present on 1, 0, 3, 0 and 1 valve exteriors, at 5-mm growth stage 28–32 costae and costellae are present on 1, 0, 2, 0 and 1 valve exteriors, whilst two valves yield approximate counts of 40 and 46 ribs at the 10-mm growth stage; one valve exterior shows about 50 ribs at the 15-mm growth stage. Concentric ornament of fine growth lines.

Ventral interior with small, stout teeth directed dorsilaterally from anterior margins of delthyrium; they are supported by strong, receding dental plates which are inclined posterolaterally and fade anterolaterally, confining the muscle field. Subtriangular to subcordate ventral muscle scar about three-quarters as long as wide extending anteriorly to about three-eighths valve length. Compound scar comprises thin lanceolate adductors flanked by subtriangular diductor lobes, each about one-sixth valve width. Elsewhere external ornament strongly impressed.

Dorsal interior with simple, linear cardinal process, slightly thickened posteriorly, situated on well-defined, anchor-shaped notothyrial platform which extends anteriorly as low, broad ridge to about one-third valve length. Posterolaterally-directed brachiophores, blade-like and widely divergent, are supported by stout club-like bases which converge slightly towards median ridge. Pair of relatively deep triangular sockets, defined by hinge and posterolateral faces of brachiophores and their bases. Laterally subcircular, poorly-defined scars impressed. Musculature comprising pair of suboval, anteriorly divergent depressions flanking cardinal process and pair of less well-defined adductor scars situated anterolaterally to notothyrial platform.

Discussion. The Herbertstown specimens are most similar to those of *Plaesiomys multiplicata* Bancroft from the Soudleyan rocks of the Glyn Ceiriog area, north Berwyns (Bancroft 1945: 245; Cocks 1978: 50; Brenchley 1978: 150). This species is characterized by a transverse outline, fine ribbing, a flat notothyrial platform somewhat larger than the cardinal process and a well-defined marginal frill, usually most marked on the pedicle valve. The Irish species also has a transverse outline. Four pedicle valves have length to width ratios of 56, 58, 69 and 72% (mean: 64%) whilst the same statistic for six Welsh pedicle valves is 58, 59, 64, 71, 71 and 71% (mean: 66%). However, since the Herbertstown valves are commonly smaller than those from Glyn Ceiriog a direct comparison of these data is not warranted although both sets of statistics are clearly similar. The maximum width of both forms is located just anterior to the hinge line.

P. multiplicata is characterized by a fine costellate ornament. With 20–26 costae, however, it has slightly more than the Herbertstown valves, with 16–20, though certainly more data from both forms are required for a statistical assessment. Poor preservation and an insufficient sample size means we can say little about the ornamental development of the Irish species, except that pedicle valves have external costellae developed by the early growth stages in the manner of the Welsh form.

As far as can be judged the interiors of both forms appear similar. Although the ventral muscle scar on the best-preserved pedicle valve from the Clashford House Formation extends to 43% of the valve length and is 77% as long as wide, examination of topotype material of *P. multiplicata* demonstrates the size and shape of the ventral muscle scar to be fairly variable; the Irish specimens are similar to the studied topotype sample.

Bancroft (1945: 244) considered the presence of a marginal frill, particularly on the pedicle valve, to be diagnostic of both *P. robusta* Bancroft, 1945, and *P. multiplicata* and could serve to separate these Costonian and Soudleyan species from the finer-ribbed, post-Marshbrookian members of the genus. Although this feature is of doubtful taxonomic value there is evidence of such a frill on the larger valves (e.g. Fig. 11) of *P.* cf. *multiplicata*.

Cocks (1978: 50) has synonymized *P. multiplicata* with *Orthis flabellulum* J. de C. Sowerby *multifida* Salter, 1866, from rocks of Caradoc age, at Llyn Idwal, Snowdon. The Herbertstown specimens have been compared with the well-documented Glyn Ceiriog species on the basis of Bancroft's description and study of a topotype sample. Similarly Diggens & Romano (1968: 47) have assigned material, from the Soudleyan Multiplicata

Sandstone at Llyn Cowlyd, north Wales, to Bancroft's species. Comparison and assessment of Salter's species must await its detailed revision.

Subfamily **ENTELETACEA** Waagen, 1884

Family **DALMANELLIDAE** Schuchert, 1913

Genus ***OANDUPORELLA*** Hints, 1975

Type species. By original designation, *Oanduporella reticulata* Hints, 1975, from the Oandu Stage (Viruan Series) of the east Baltic.

Oanduporella cf. ***reticulata*** Hints 1975
Figs 25–37

cf. 1975 *Oanduporella reticulata* Hints: 19, 105; pl. 1, figs 1–15; pl. 2, figs 1–5.
1980*b* ?*Ravozetina*/*Onnizetina*; Mitchell *in* Romano: 206.

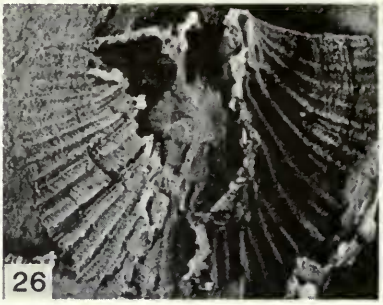
Material. Seventeen pedicle valves, eighteen brachial valves and four indeterminate valves. There are five conjoined pairs.

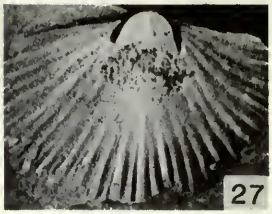
Description. Ventribiconvex valves of rounded transverse to subquadrate outline with maximum width just posterior to mid-valve length; hinge width about nine-tenths maximum width with angular and obtuse cardinal extremities. Pedicle valve about two-thirds as long as wide and about one-third as deep as long. Anterior profile convex with marked subcarinate axial surface and flatly convex flanks; lateral profile with maximum convexity at umbo, elsewhere valve surface weakly concave. Ventral interarea flat, with relatively wide, open delthyrium. Brachial valve about two-thirds as long as wide and about one-quarter as deep as long. Anterior profile with relatively deep and well-marked sulcus having flat, steeply inclined sides and an angular base, originating at about 1-mm growth stage and developing markedly anteriorly; flanks convex. Lateral profile with small convex umbo, elsewhere valve surface slopes gently anteriorly. Dorsal interarea short, flat and anacline; notothyrium open and wide. Radial ornament of strong costae and costellae of angular and subangular profiles with about 5–6 per 2 mm, medially at 5 mm growth stage; interspaces are rounded and semicircular, with net-like microsculpture of suboval pits with diameters of 0·1–0·15 mm at 4 mm medially from posterior margin.

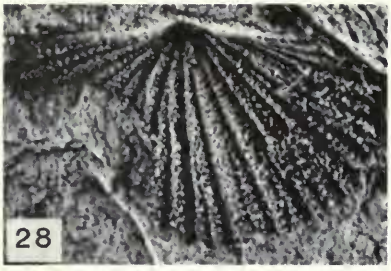
Ventral interior with minute, subtriangular teeth supported by near vertical dental plates, which initially diverge anteriorly; at mid-length plates anteriorly convergent and confining muscle field. Muscle scars about as long as wide, extending anteriorly to about one-quarter valve length and comprising centrally situated adductors flanked by diductor lobes. Elsewhere external ornament weakly impressed.

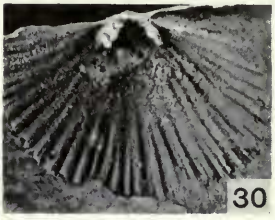
Dorsal interior with cardinal process consisting of long linear shaft, expanded slightly posteriorly to form simple myophragm, and extending anteriorly to edge of notothyrial platform. Flanking brachiophores relatively thin and slightly divergent from their near-vertical, thicker, bases which extend ventrally from lateral margins of notothyrial platform. Platform about two-thirds as wide as long, extending to about one-quarter valve length, from where it continues anteriorly as low broad ridge, fading out near mid-valve length; high subparallel brachiophores and their bases flank crudely rectangular notothyrial chamber. Diductor scars impressed on floor of notothyrial platform which is bisected medially by cardinal process. Adductor scars relatively large, each elongately oval, about three-quarters as wide as long, and extending anteriorly from front of brachiophores and divided medially by low, broad ridge. Elsewhere external ornament feebly impressed, though locally microsculpture is well defined.

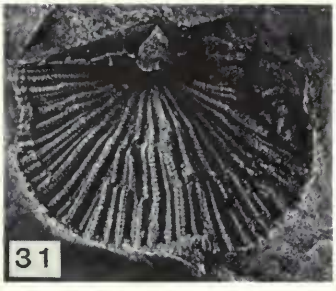
Discussion. Hints defined her new genus *Oanduporella*, from the Oandu Stage of the Viruan Series in the east Baltic, in terms of its ventribiconvexity, elongate dorsal adductors

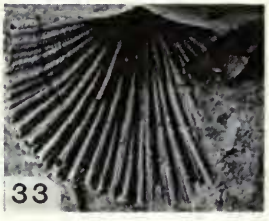


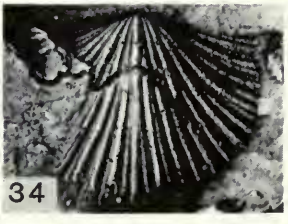


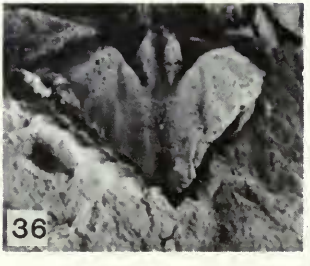


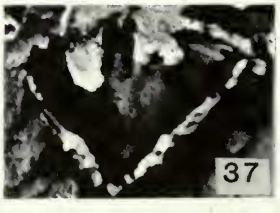












Figs 25–37 *Oanduporella* cf. *reticulata* Hints. Figs 25, 26, BC 9182, partly exfoliated dorsal interior and latex cast, both × 8. Figs 27, 30, BC 9183, internal mould and latex cast of pedicle valve, both × 5. Figs 28, 29, BC 9184, external and internal moulds of brachial valve, both × 14. Figs 31, 32, BC 9185, external mould and latex cast of brachial valve, both × 8. Figs 33, 34, BC 9186, external mould and latex cast of pedicle valve, both × 5. Fig. 35, BC 9187 (top) and BC 9188, pair of latex casts of external moulds of brachial valves, × 5. Figs 36, 37, BC 9189, internal mould and latex cast of brachial valve, both × 10. Clashford House Formation.

and fine, net-like microsculpture between the ribs (1975: 105). It is closely related to *Fascifera* Ulrich & Cooper, but differs in having stronger ribbing, more elongate dorsal adductor scars and in the intercostellate microsculpture. Wright (1981: 460) has discussed the significance of this microsculpture and considered the pits to represent the external appearance of caeca; the distinctive shell fabric results from the secretion of calcite at the mantle edge from cells surrounding puncta (Wright 1981: 460).

The Herbertstown material is assigned to *Oanduporella* and represents the first record of the genus from the British Isles; the microsculpture is particularly well developed on the shells of the smaller specimens, although on larger specimens the intercostal furrows are deeper and therefore the pitting is less obvious.

Although much of the Herbertstown material is deformed it appears comparable in shape and internal features to those of the type species, *Oanduporella reticulata* Hints (1975: 19, 105; pl. 1, figs 1–14; pl. 2, figs 1–5). The radial ornaments of both forms are similar; medially 5–6 costae and costellae are present per 2 mm at the 5-mm growth stage, and on brachial valve exteriors the following costellae are present by the 4-mm growth stage: $1a^{-}$, $2a^{-}$, $3a^{-}$, $4a^{-}$, $5a^{\circ}$, $5a^{-}$, $6a^{\circ}$, $6a^{-}$. The diameter of the pits on brachial valve exteriors of the Irish form is in the range 0·1–0·15 mm, medially at the 4-mm growth stage, which is similar to that noted for the Estonian species (see Wright 1981: 460).

Order **STROPHOMENIDA** Öpik, 1934

Suborder **STROPHOMENIDINA** Öpik, 1934

Superfamily **PLECTAMBONITACEA** Jones, 1928

Family **SOWERBYELLIDAE** Öpik, 1933

Subfamily **AEGIROMENINAE** Havlíček, 1961

Genus ***SERICOIDEA*** Lindström, 1953

Type species. By original designation, *Leptaena sericea* J. de C. Sowerby var. *restricta* Hadding, 1913, from the Chasmops beds (middle Ordovician) of the Fågelsång district, Sweden.

Sericoidea cf. ***abdita*** Williams 1955
Figs 38–42

cf. 1955 *Sericoidea abdita* Williams *in* Whittington & Williams: 418; pl. 39, figs 83–85.
aff. 1962 *Sericoidea* aff. *abdita* Williams; Williams: 188; pl. 18, figs 10–15.
cf. 1968 *Sericoidea abdita* Williams; Bates: 173; pl. 9, figs 3, 6.
cf. 1974 *Sericoidea* cf. *abdita* Williams; Williams: 139; pl. 24, figs 8, 9, 12, 15, 17, 18; pl. 28, fig. 16.
cf. 1978 *Sericoidea abdita* Williams; Cocks: 104.

Material. Six pedicle valves and two brachial valves, most of which are broken and poorly preserved.

Description. Minute, rectimarginate, planoconvex to concavoconvex valves of transverse to semicircular outline with maximum width at hinge line; cardinal extremities angular and acute. Pedicle valve with evenly convex anterior and lateral profiles, about two-thirds as long as wide and about one-fifth as deep as long. Brachial valve about two-thirds as long as wide with weakly concave anterior and lateral profiles. Ventral and dorsal interareas both short and flat – apsacline and anacline respectively; delthyrium apparently open, details of notothyrium not known. Radial ornament unequally parvicostellate with about 12 costae and costellae per mm, medially at and near the 2-mm growth stage. Fine concentric growth lines occasionally thickened to form feeble rugae. Ventral interior with small teeth marking anterolateral margins of delthyrium, not supported. Ventral muscle scar subcordate,

comprising minute, elongately oval adductors surrounded by markedly larger diductor lobes; compound scar about as wide as long and extending anteriorly to about one-sixth valve length. Low broad ridge extends anteriorly from front of muscle scar to about three-fifths of valve length. Elsewhere external ornament strongly impressed and coarse pustules sporadically developed. Dorsal interior with prominent median septum flanked by at least three pairs of pustules; dorsal platform obscure. Cardinalia not known.

Discussion. The Herbertstown material is compared with *S. abdita* on account of its semicircular outline, ribbing density and apparently simple septule configuration in the brachial valve.

Family **LEPTAENIDAE** Hall & Clark, 1894

Genus ***KIAEROMENA*** Spjeldnæs, 1957

Type species. By original designation, *Leptaena kjerulfi* Holtedahl, 1916, from the Lower Chasmops Limestone (middle Ordovician) of the Oslo Region.

Kiaeromena sp.
Figs 43–46

Material. Two incomplete and relatively poorly preserved pedicle valves, slightly tectonically deformed.

Description. Large subquadrate pedicle valve with marked dorsal geniculation, about three-quarters as long as wide and about one-tenth as deep as long. Geniculation at approximately two-thirds valve length; disc about 20 mm long with curved trail about 15 mm long. Anterior and lateral profiles of disc weakly convex though modified locally by rugae; umbo prominent. Interarea short, flat and apsacline; delthyrium partly covered by small pseudodeltidium. Radial ornament of fine, unequal parvicostellae on both disc and trail numbering, medially, 5, 4 and 2 at the 5, 10 and 20-mm growth stages respectively. At least six fairly strong but variably developed concentric rugae restricted to disc with wavelengths of about 5 mm, having asymmetrical profiles with shorter, steeper posterior-facing slopes.

Ventral interior with small triangular teeth supported by widely divergent dental plates extending anteriorly to about one-tenth of valve length and confining the weakly impressed, elongately oval muscle scar. Valve interior pustulate.

Discussion. Although the only well-preserved valve of this species is tectonically deformed it is sufficiently distinctive and well enough preserved to allow an unequivocal generic placement. The Herbertstown material is most similar to *Kiaeromena* cf. *kjerulfi* (Holtedahl, 1916) from the Hagley Volcanic Group and Whittery Shales (both Soudleyan) of the Shelve inlier, and to *K.* cf. *kjerulfi* from the Allt Ddu Group (Soudleyan) of the Bala district. Further comparison with those forms and the Norwegian members of the genus (Spjeldnæs 1957) is not warranted on the available material.

Figs 38–42 *Sericoidea* cf. *abdita* Williams. Fig. 38, BC 9190, internal mould of pedicle valve, × 16. Fig. 39, BC 9191, internal mould of brachial valve, × 16. Fig. 40, BC 9192, internal mould of pedicle valve, × 12. Figs 41, 42, BC 9193, external mould and latex cast of pedicle valve, × 16. Clashford House Formation.

Figs 43–46 *Kiaeromena* sp.. Figs 43, 45, 44, 46, BC 9194, internal mould and latex cast of pedicle valve, and external mould and latex cast of same pedicle valve, all × 1½. (For borings, see p. 290). Clashford House Formation.

Figs 47–52 *Hibernodonta praeco* gen. et sp. nov. Figs 47, 50, BC 9195, latex cast and external mould of brachial valve, both × 6. Figs 48, 49, BC 9196, internal mould and latex cast of brachial valve, both × 6. Figs 51, 52, **Holotype** BC 9197, latex cast and internal mould of pedicle valve, both × 6. Clashford House Formation.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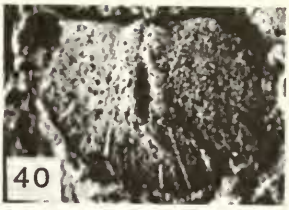
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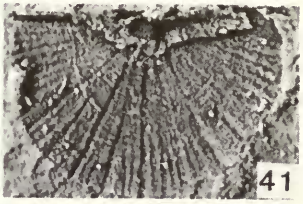
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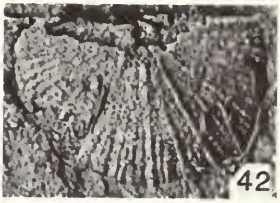
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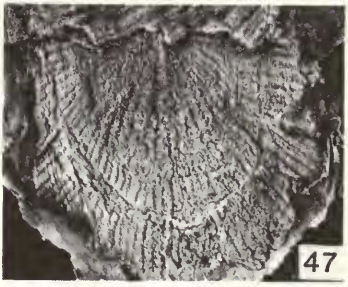
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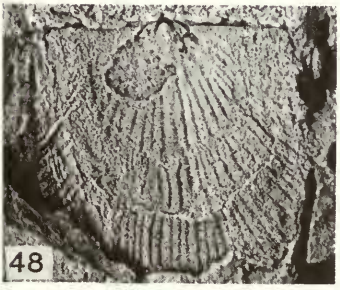
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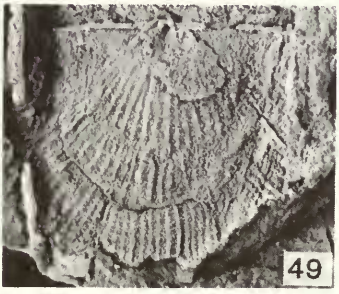
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Family **STROPHEODONTIDAE** Caster, 1939

Subfamily **STROPHEODONTINAE** Caster, 1939

Genus ***HIBERNODONTA*** nov.

NAME. Latin 'Hibernia' – Ireland.

TYPE SPECIES. *Hibernodonta praeco* gen. et sp. nov.; from the Clashford House Formation (middle Caradoc), near Herbertstown, Co. Meath, Ireland.

DIAGNOSIS. Small stropheodontinine genus with wide, open delthyrium, widely divergent dental plates and prominent arched chilidium. Ornament of dichotomously branching costae and costellae; the median costa commonly accentuated. Rugae variably developed.

DISCUSSION. The new genus possesses many of the features usually ascribed to *Rafinesquina* Hall & Clarke, 1892. In particular the outline and profiles of each valve, the cardinalia and ventral musculature are virtually identical. The presence of denticles along much of the hinge line, however, suggests the inclusion of the Herbertstown material within the Stropheodontidae.

Amsden (1974: 52–53) discussed the morphology of the type species of *Rafinesquina, Leptaena alternata* Conrad, from the Trenton Limestone, and assessed the generic features of the closely related *Eostropheodonta* Bancroft, 1949. He could not confidently discount the presence of denticles or striations on the teeth of one ventral interior of *L. alternata* examined, but emphasized that similar denticles are present on the teeth of many specimens assigned to *Rafinesquina* in the collections of the United States National Museum. Thus although *Brachyprion stropheodontoides*, a form he described from the Noix Limestone of Missouri, possesses many of the attributes of *Eostropheodonta*, for example the denticulate teeth and dental plates, an open delthyrium and a chilidium, Amsden (1974: 52–53) preferred to assign the species to *Rafinesquina* tentatively, pending a more complete revision of that genus. The fundamental difference between the two genera is generally accepted as the presence of denticles or striations on the teeth in *Eostropheodonta*; however it is noteworthy that Havlíček (1967: 81) considered such a difference insufficient to place that genus within the Stropheodontidae but preferred to have it in the eponymous family within the Strophomenacea. Havlíček considered that the Eostropheodontidae represent a distinct stock derived independently from the Rafinesquinidae, not intimately related to the stropheodontids (cf. Williams 1953). A number of other strophomenaceans have developed similar dental striations or denticles and have as a result been erroneously referred to, for example, *Eostropheodonta* (e.g. *Oepikina williamsi* (Spjeldnæs, 1957) from the middle Ordovician of the Oslo region) and *Stropheodonta* [*sic*] (e.g. *Strophomena bilix* (Lamont, 1935) from the Lower Drummuck Group (Cautleyan Stage – Ashgill Series) of the Girvan district). *Aphanomena* Bergström (1968: 13), however, has denticles developed on the socket ridges and is thought to have been derived from a *Kjaerina*-like form. Although the significance of these features within those stocks has yet to be assessed in detail, they serve to demonstrate that the development of this type of dentition is polyphyletic.

Cocks (1978: 124) commented upon stropheodontid classification; he considered that denticles probably arose in three lineages independently. The first group contains those forms which may have evolved from *Rafinesquina* and includes *Eostropheodonta*. Although this is almost certainly true, as discussed previously that genus is better retained outside the Stropheodontidae. *Hibernodonta*, however, is quite different and possesses many features typical of the more primitive, *Rafinesquina*-like stropheodontids. The delthyrium is wide and open whilst the notothyrium is closed by a large chilidium; dental plates are well developed and these diverge anteriorly. In the first two respects *Hibernodonta* resembles *Origostrophia* Mitchell, 1977 from the Killey Bridge Formation (Cautleyan Stage – Ashgill Series) of Pomeroy, Northern Ireland. However, the Herbertstown genus possesses well-developed dental plates; evidence of a pedicle foramen or ventral process is lacking. Although both genera have a thickened median rib the Pomeroy specimens have a much finer costellate ornament.

Excluding *Eostropheodonta* from the Stropheodontidae proper, the available evidence would indicate *Hibernodonta* as clearly one of the progenitors of the subsequent stropheodontinine plexus which flourished during the Silurian.

Hibernodonta praeco gen. et sp. nov.
Figs 47–52

NAME. Latin '*praeco*' – a herald or crier.

MATERIAL. Two pedicle valves, three brachial valves and four indeterminate valves all relatively complete.

HOLOTYPE. A pedicle valve, BC 9197. British Museum (Natural History), London.

DIAGNOSIS. A *Hibernodonta* species of elongate subquadrate outline with a radial ornament of dichotomously branching costae and costellae numbering about five per mm, medially, at the 5-mm growth stage; concentric growth lines variably thickened to form rugae.

DESCRIPTION. Relatively small, planoconvex valves of elongate subquadrate outline with maximum width at hinge line; cardinal extremities sharp and rectangular. Anterior commissure rectimarginate. Pedicle valve about as wide as long and about one-quarter as deep as long. Anterior profile gently convex with maximum curvature medially; lateral profile convex posteriorly to near mid-valve, flattening anteriorly. Interarea flat, about one-tenth of valve length and apsacline; wide, open delthyrium, the margins of which diverge anteriorly at right angles and are continuous with the dental plates. Hinge line denticulate along at least three-quarters of width. Denticles with rounded profiles, expanded slightly anteriorly, with outermost few directed anterolaterally; they number about 5 per mm and are situated on a low denticular plate which is about two-fifths as long as interarea. Brachial valve about four-fifths as long as wide with anterior and lateral profiles essentially flat, modified locally by strong concentric growth lines and rugae. Interarea flat, short and anacline, bearing complementary sockets and ridges. Notothyrium covered by prominent, arched chilidium. Ornament of evenly rounded costae and costellae which anteriorly develop markedly. About 20 arise at the umbo, the median six of which commonly branch dichotomously at or near the 2-mm growth stage; median rib thickened throughout early growth stages. Concentric ornament of fine concentric growth lines variably developed as rugae.

Ventral interior with pair of thin, virtually vertical, dental plates which diverge widely anteriorly from margins of delthyrium. Deep conical sockets present between dental plates and hinge. Muscle scars faintly impressed.

Dorsal interior characterized by a pair of strong cardinal process lobes which are markedly expanded posteroventrally, converging posteriorly and situated on low notothyrial platform with deep median depression. Socket ridges fairly short, slender, arising just lateral to posterior end of cardinal processes and diverging anteriorly at about 120°.

DISCUSSION. For the present no other species can be assigned to *Hibernodonta* and little biometrical data are available to define the relative dimensions of the material and their variation.

Systematic palaeontology: Trilobita

Family **AULACOPLEURIDAE** Angelin, 1854

Subfamily **AULACOPLEURINAE** Angelin, 1854

Genus ***HARPIDELLA*** M'Coy, 1849

TYPE SPECIES. By monotypy, *Harpes megalops* M'Coy, 1846: 54–55; pl. 4, fig. 5; from the Upper Llandovery at Boocaun, Cong, Co. Galway.

Harpidella? sp.
Fig. 53

MATERIAL. An incomplete internal mould of a cranidium.

DISCUSSION. This specimen broadly resembles several Ordovician species which historically have been ascribed to *Otarion* Zenker. As Owen & Bruton (1980: 19) noted, these forms should now be excluded from *Otarion* in the light of Thomas & Owens' work (1978), but their generic placement remains unclear. The absence of S2 in the Herbertstown cranidium suggests placement in *Cyphaspis* Burmeister, but the glabella does not overhang the preglabellar field and thus resembles *Harpidella*. A tentative ascription to the latter genus broadly follows the approach adopted by Owen & Bruton and others.

The small L1 in the present specimen invites comparison with '*Otarion*' sp. A of Tripp (1962) and '*O.*' sp. B of Tripp (1976) from, respectively, upper Llanvirn and lower Llandeilo strata near Girvan, south-west Scotland. Both these forms, however, have a longer (sag., exsag.) preglabellar field. In addition, '*O.*' sp. A has a very strongly tapered glabella and '*O.*' sp. B has a more elongate glabella. The *Harpidella* sp. cranidium figured by Tripp (1980: pl. 2, fig. 24) from the lower Ardwell group (middle Caradoc) near Girvan has a similar preglabellar field to that of the Herbertstown specimen but has a more elongate glabella and L1.

Family **ENCRINURIDAE** Angelin, 1854

Subfamily **CYBELINAE** Holliday, 1942

Genus ***DEACYBELE*** Whittington, 1965

TYPE SPECIES. Original designation, *Calymene arenosa* M'Coy, 1846: 47; pl. 4, fig. 12; from probable Caradoc strata at Ballygarvan Bridge, New Ross, Co. Wexford.

DISCUSSION. *Deacybele* was diagnosed originally (Whittington 1965: 46–48) to comprise a group of Caradoc cybelines in which the glabellar lobes are large and discrete. Details of the anterior cranidial border were not known at that time. Owen & Bruton (1980) illustrated this area in *D. gracilis* (Nikolaisen, 1961) where it is developed as a single tubercle-like projection similar to that of *Cybeloides* Slocom. Owen (1981) described a lower Ashgill species, *D. conjuncta*, in which there is coalescence of the lateral parts of the glabellar lobes in some specimens. As Owen (1981: 55) noted, this may represent a reversion to the condition in *Cybeloides*, if that was the ancestor of *Deacybele*, or may indicate that *Deacybele* is not a monophyletic group but represents the repeated development of discrete lobes within *Cybeloides*. As an added complication, it should be noted that the 'compound lobes' (pulvini) in *Cybeloides* were shown by Evitt & Tripp (1977) to contain elements of the fixed cheeks incorporated in the glabella during ontogeny, and thus the discrete lobes in species of *Deacybele* may not be truly homologous with the glabellar lobes in other trilobites.

The Herbertstown cranidium has discrete lobes on the glabella and its overall morphology is close to that of the type species of *Deacybele, D. arenosa*. The anterior margin is preserved and, unlike *D. gracilis*, shows an arc of small tubercles in front of a shallow furrow and thus resembles the condition in *Atractopyge* and *Cybellela*. A cranidium of *D. conjuncta* illustrated by Owen (1981: pl. 12, fig. 24) shows a similar structure. Thus the variation between species currently assigned to *Deacybele* now throws considerable doubt on the phylogenetic homogeneity of the genus. This will only be resolved satisfactorily once more material of the less completely known species (including the type species) is available and other relationships within the Cybelinae as a whole have been clarified.

Deacybele aff. ***arenosa*** (M'Coy 1946)
Figs 54–59

MATERIAL. Three cranidia, two free cheeks, two hypostomata and a pygidium. Most specimens are internal moulds but counterpart external moulds of two cranidia and the pygidium are present.

Description. Despite the fragmentary condition of most of the specimens, a fairly full description can be given. Cranidium having a sagittal length equal to approximately 25% of the posterior width. Glabella concave-sided with the width of the occipital ring approximately equal to that of the frontal lobe. Occipital ring occupies approximately 20% of the sagittal glabellar length, tapering markedly distally and bearing a prominent median tubercle on its posterior half. Occipital furrow transversely directed. Three pairs of glabellar lobes occupy a little over 50% of the transverse glabellar width. L1 almost completely circumscribed by furrows. L2 transversely-directed, ridge-like, not quite as extensive abaxially as the other two lobes. L3 expanding a little abaxially. S3 diverging forwards at 130° although this figure may have been increased by distortion. Anteriorly the glabella is delimited by a very weakly impressed furrow which is arched strongly forwards. In front of this is a narrow (sag., exsag.) border bearing a single arc of small tubercles. Dorsal furrow deepest opposite L2. Posterior border narrow proximally, broadening (exsag.) considerably abaxially. Genal angle rounded. Posterior border furrow transversely-directed and deep over most of its length, but curving gently forwards and shallowing distally. Base of palpebral stalk situated opposite L2 and a weak eye ridge directed towards L3. Posterior branch of facial suture transversely-directed. Details of anterior branch not known. External and internal surfaces of glabella bear small scattered granules, and prominent paired tubercles are situated approximately between the ends of L1, S2 and S3 and on the mid-part of the frontal lobe. Field of fixed cheek bears a few granules set against a subdued, dense pitting.

Border of free cheek weakly swollen, defined by a shallow border furrow. Internal mould of field bears a large number of irregularly distributed granules.

Hypostoma broadly similar to that of *Cybeloides* (*Paracybeloides*) (e.g. Ingham 1968: pl. 1, fig. 15) in having a swollen rhynchos (see Evitt & Tripp 1977: 114), swollen maculae and a triangular outline. This is the first hypostoma to be ascribed to *Deacybele* and emphasizes the similarity of many aspects of the genus to *Cybeloides*. The anterior margin is arched gently forwards, the lateral borders narrow and ridge-like and the posterior borders are broad, converging rearwards at about 80°.

Thorax not known. Length of pygidium (excluding spines) approximately equal to maximum width. Rachis tapers gently rearwards, occupying 70% of pygidial length and comprising a large articulating half-ring and at least 12 rings. Only the first ring is distinct over the entire width of the rachis; the others are only defined laterally. Four pairs of pleural ribs are present. The anterior rib has a well-developed anterior band. Those of the second and third ribs are less conspicuous and the posterior rib lacks such a band. First three pairs of pleural ribs arched abaxially. Fourth pair follows the sides of the posterior part of the rachis and converges at the same angle behind the rachis to the level at which, presumably, the ribs fan outwards as spines although this is not preserved in the only specimen available.

Discussion. The type of species of *Deacybele, D. arenosa*, was redescribed by Whittington (1965: 48–49; pl. 14, figs 1–6; text-fig. 3A) on the basis of topotype cranidia from the probable Caradoc strata at Ballygarvan Bridge, Co. Wexford and a cranidium from Lower Caradoc strata at Greenville, Enniscorthy (see Brenchley *et al.* 1977: 70). This material is incomplete and details of the anterior margin of the cranidium are not clear. Nevertheless, the Herbertstown cranidia show several similarities to *D. arenosa*, most importantly in the absence of genal spines. The more transverse outline of the glabellar lobes in the present material is almost certainly a result of deformation which is also reflected in the development of transverse ridges crossing the glabellar stem. The main feature distinguishing this material from *D. arenosa* is the development of distinct paired tubercles on the glabella in the Herbertstown form.

D. pauca Whittington, 1965 from middle Caradoc strata in north Wales and *D. gracilis* (Nikolaisen, 1961) from upper Caradoc and lowest Ashgill horizons in Norway differ from *D. arenosa* and *D.* aff. *arenosa* in having genal spines. The anterior part of the cranidium in *D. pauca* is not known but that of *D. gracilis* is a single tubercle-like projection (Owen & Bruton 1980). *D. conjuncta* Owen, 1981 from the lower Ashgill of Norway appears to lack

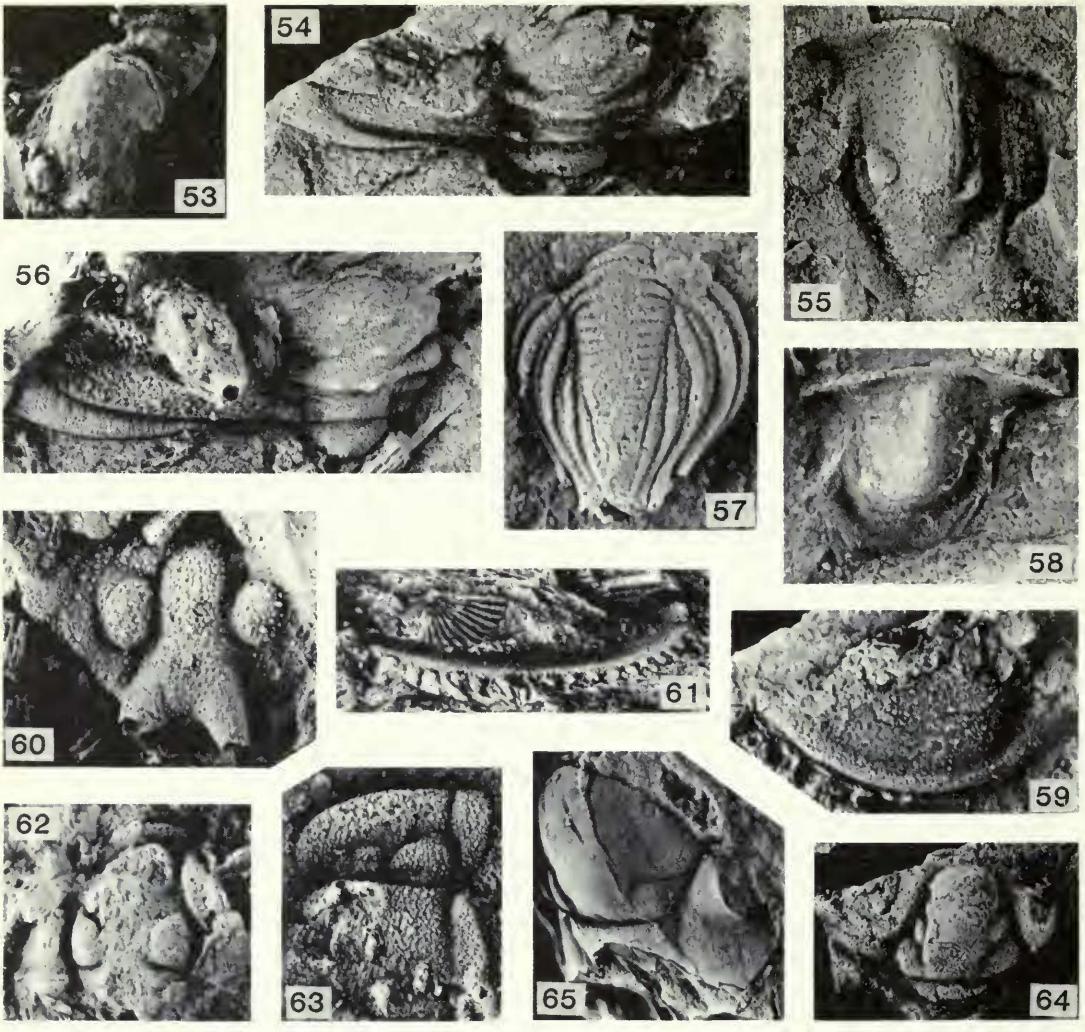

Fig. 53 *Harpidella*? sp. It 17040, dorsal view of incomplete internal mould of cranidium, × 7½. Clashford House Formation.

Figs 54–59 *Deacybele* aff. *arenosa* (M'Coy). Fig. 54, It 17042, dorsal view of cranidium, × 6. Fig. 55, It 17043, ventral view of latex cast of hypostoma, × 7½. Fig. 56, It 17042a, dorsal view of latex cast of cranidium (same specimen as Fig. 54), × 7. Fig. 57, It 17044a, dorsal view of latex cast of pygidium, × 14. Fig. 58, It 17041a, ventral view of latex cast of hypostoma, × 7½. Fig. 59, It 17045, lateral view of internal mould of free cheek, × 7. Clashford House Formation.

Figs 60–61 *Miraspis* sp. Fig. 60, It 17050, dorsal view of latex cast of cranidium, × 7½. Fig. 61, It 17051, lateral view of spinose lateral border of free cheek, ×7½. Clashford House Formation.

Figs 62–64 *Gravicalymene* sp. Fig. 62, It 17046, dorsal view of internal mould of distorted cranidium, × 7½. Fig. 63, It 17047a, lateral view of latex cast of cranidium, × 8. Fig. 64, It 17048, dorsal view of internal mould of cranidium, × 7½. Clashford House Formation.

Fig. 65 Lichid gen. et sp. indet. It 17049, ventral view of internal mould of distorted hypostoma, × 3. Clashford House Formation.

genal spines and has an anterior cranidial border like that of *D.* aff. *arenosa*, but differs in having a much denser glabellar granulation lacking paired tubercles and in some specimens having the glabellar lobes fused distally.

A single specimen of *D.* cf. *pauca* was recorded from the lower Caradoc Brickworks Quarry Shales of the Grangegeeth area further north (Romano 1980*a*). Although the specimen is incomplete, the genal angles and anterior border being missing, it differs from *D.* aff. *arenosa* in that the posterior borders are of more constant width (exsag.) and the occipital ring is less distinct.

Family **CALYMENIDAE** Milne Edwards, 1840

Subfamily **FLEXICALYMENINAE** Siveter, 1977

Genus ***GRAVICALYMENE*** Shirley, 1936

Type species. Original designation, *Gravicalymene convolva* Shirley, 1936: 409; pl. 29, figs 16–18; from the Birdshill Limestone (Ashgill), near Llandeilo, south Wales.

Gravicalymene sp.
Figs 62–64

Material. Four incomplete internal moulds of cranidia.

Discussion. The bell-shaped glabella and slightly sinuous dorsal furrows indicate that these cranidia belong in *Gravicalymene* (see Price 1982: 58 for a discussion of the genus). The preglabellar area is partially seen in one specimen (Fig. 62) where it is short (sag., exsag.) with a ridge-like, upturned anterior portion. This and the overall glabellar proportions suggests some affinity to *G. jugifera* Dean, 1962 (see also Ingham 1977) from Pusgillian strata in the north of England, but the present material is too poorly preserved for detailed comparison.

Family **LICHIDAE** Hawle & Corda, 1847

Lichid gen. et sp. indet.
Fig. 65

Material. One distorted hypostoma.

Discussion. This specimen is heavily distorted, the left side having undergone considerable shortening and the right side being expanded somewhat. The overall shape of the median body and the borders suggests an affinity to either *Platylichas* Gurich, 1901 or *Amphilichas* Raymond, 1905.

Family **ODONTOPLEURIDAE** Burmeister, 1843

Subfamily **MIRASPIDINAE** Richter & Richter, 1917

Genus ***MIRASPIS*** Richter & Richter, 1917

Type species. Original designation, *Odontopleura mira* Barrande, 1846: 57; from the Liten Formation (Wenlock) near Béroun, Czechoslovakia.

Miraspis sp.
Figs 60–61

Material. A free cheek (part and counterpart) and the external mould of an incomplete cranidium.

Discussion. The stalked palpebral lobe and paired occipital spines indicate that this specimen belongs in *Miraspis*, although the latter feature alone is not diagnostic (Owen & Bruton 1980: 36). The combination of very robust occipital spines, large occipital ring, no median occipital protuberance, very weakly impressed occipital furrow and large extension of the fixed cheek behind L1 together distinguish the Herbertstown cranidium from other described species of *Miraspis*. The present specimen is too incomplete, however, to warrant the establishment of a new species at this stage.

The specimen is close to *M. solbergensis* Bruton, 1966 from the Boda Limestone (Ashgill) in Siljan, Sweden in terms of size of occipital ring, definition of occipital furrow and posterior fixed cheek development. The Swedish species, however, has a median occipital tubercle, more slender occipital spines, a less swollen median glabellar lobe, a more circular L1 outline and a much sparser cranidial granulation.

Miraspis sp. from the Brickwork's Quarry Shales of Grangegeeth (Romano 1980*a*) possesses less robust occipital spines, a more circular L1 outline and weaker furrows delimiting the median glabellar lobe than in the Herbertstown material.

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